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14. ABSTRACT The main goal of the project was to establish a terascale parallel computer cluster on our campus to be shared by the Scientific Computing group, comprised of members of five departments and three colleges at the University of Massachusetts Dartmouth. One of the novel aspects of the proposed computer system is the use of many-core GPUs as hardware accelerators for large scale scientific computation. In The procured system is a 256 CPU IBM iDataPlex system which includes 32 Nvidia Fermi M2050 GPUs as accelerators. The system has been installed, configured and is currently in full operation at the University Data Center. Members of the Scientific Computing group (the investigators and their students) have been successful in 'porting' over their research codes to this new system and are currently in the process of performing detailed tests. Although the system has only been in operation for a few short months, the cluster was already used to perform detailed simulations of the gravitational wave emission from an extreme-mass-ratio black hole binary system. This work resulted in a fast publication in Physical Review. More work is ongoing in the fields of computational mathematics, civil engineering, mechanical engineering, physics, and geophysics.					
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(DURIP-10) A HETEROGENEOUS TERASCALE COMPUTING CLUSTER FOR THE DEVELOPMENT OF GPU OPTIMIZED HIGH ORDER NUMERICAL METHODS

Final Report

Aims: The main goal of the project was to establish a terascale parallel computer cluster on our campus to be shared by a number of research groups and departments. One of the novel aspects of the proposed computer system is the use of many-core GPUs as hardware accelerators for floating-point computation. In addition to advancing the specific computational research projects of the involved investigators, this campus instrument is also meant to enhance the educational mission of the institution through the training of students on its use and upkeep.

Progress: The procured system is a 256 CPU IBM iDataPlex system which includes 32 Nvidia Fermi M2050 GPUs as accelerators. The system has been installed, configured and is currently in full operation at the University Data Center. Members of the Scientific Computing group (the investigators and their students) have been successful in 'porting' over their research codes to this new system and are currently in the process of performing detailed tests. Within a few short months, the new GPU cluster installed at UMass Dartmouth is being deployed on a wide range of problems -- ranging from computational astrophysics to fluid mechanics to physical oceanography to computational chemistry -- by a variety of researchers across our campus.

The use of GPUs as accelerators for scientific computing is a relatively new approach, thus there is a significant level of education and training involved for all project participants. The various computer codes used by the involved research groups be developed to take full advantage of the different levels of parallelism that this computer system offers -- for example, a coarse-grain level of parallelism through the use of message-passing (MPI) over the multiple-nodes and also a fine-grain form of parallelism, based on the many-cores of the GPU accelerator on each node. In addition, making effective use of rapidly evolving computer processor technologies (such as CUDA and OpenCL) requires us to stay on a constant learning path.

Although the system has only been in operation for a few short months, the cluster was already used to perform detailed simulations of the gravitational wave emission from an extreme-mass-ratio black hole binary system. This work resulted in a fast publication in Physical Review.